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Does Economic Growth Increase the Demand for Schools?  
Evidence from Rural India, 1960-1999

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Abstract

Are low levels of schooling infrastructure—in particular, access to secondary schools—and low schooling investment solely the result of failed educational policies, or do they reflect the low school demand that stems from slow economic growth? This paper examines this question by analyzing a large data set in a framework that bases human capital investment on expected returns to schooling. It first shows that growth increases schooling inequality primarily because agricultural technological change increases schooling in landed but not landless households. But growth also affects other variables that influence schooling outcomes, of which child wages and school construction are considered. The analysis finds that the operation of the child labor market worsens the distributional impact of agricultural productivity on school investments across landless and landed households, as landless child labor substitutes for the labor of children from landowning households who have increased their attendance in schools. On the other hand, school construction increases most in areas where expected future productivity increases are highest. This paper also finds that closer proximity to schools differentially benefits landless households. The policy implication of this paper is that human capital can be increased, not only by education policies aimed at expanding school supply, but more importantly, by stimulating the demand for schooling through faster, sustained economic growth.

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1. Introduction

Many social scientists have argued that a benchmark for assessing the performance of a country is the human capital of its citizens. And there is no doubt that India has lagged behind most of the countries of the world in terms of the educational attainment of its population. In recent years most of the research on the determinants of human capital investment in low-income countries has focused on educational policies. Much of this literature addressing the effects of school policies emphasizes the supply of schooling services. And, some of this research has indeed demonstrated that lack of access to schools and poor school quality do contribute to low schooling attainment (e.g., Duflo, 1999; Kochar, 2000). This research approach neglects, however, factors that affect schooling demand, namely schooling returns.2

Many economists (Welch, 1970; Schultz, 1975; Nelson and Phelps, 1966) have argued that an important determinant of the returns to schooling is growth itself - the returns to general skills are enhanced in a dynamic environment in which skill in decoding information and in decision-making under changing circumstances have high payoffs. Empirical studies based on farm-level, county-level and cross-country data have shown that returns to schooling are indeed greater in dynamic settings ((Welch, 1970; Foster and Rosenzweig, 1996; Rosenzweig, 1995; Lau et al., 1993; Benhabib and Spiegel, 1994). Foster and Rosenzweig (1996), in particular, have shown that the returns to schooling rose more in areas of India in which the green-revolution seed technology advanced most rapidly. There has been little study, however, of how the returns to schooling affect educational choices and how schooling returns are related to economic growth.

In this paper we examine whether low levels of schooling infrastructure - in particular, access to secondary schools - and low schooling investment are solely the product of failed educational polices or whether they reflect instead, or at least in addition, inadequate economic

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2 The emphasis on educational policy has been buttressed by research showing that wealth differences across areas of India have little to do with schooling investments (Dreze and Sen, 1998). However, cross-sectional wealth differences are not a good proxy for economic growth, which has important effects on the returns to schooling. It is not obvious that the returns to schooling are higher among wealthy families, and we show below that among farm households, high wealth and schooling costs are positively related.

3 A possible reason for this neglect is that the existence of high returns to schooling is taken for granted. Evidence is often cited of high returns in low-income countries based on wage regressions (Psacharopoulos, 1998). But these estimates are from highly selective samples of, usually, wage workers, which have little relevance to rural populations where many individuals are self-employed.
policies and consequently low school demand. Do poor economic growth performance and the lack of opportunity to exploit the skills that schooling produces importantly affect investments in school infrastructure, or does lack of school access solely reflect mismanagement of the economy? We use a newly-available and assembled time series data on 240 rural villages spread throughout almost all of India covering the last 40 years to test the hypothesis that an important determinant of school building and of schooling investment has been the expectations of future economic growth by local populations.

We begin in part 2 with a simple model that incorporates the basic idea that investments in schools are made based on expectations of schooling returns, which are augmented when productivity is expected to rise more rapidly. We show that in the rural sector the appreciation of land prices will reflect changes in farmers’ expectations of future productivity growth, and use the variation across villages and over time in yield growth rates, land prices and school construction to estimate the effects of expected yield growth, wealth levels, and the stock of existing schools on secondary school construction and on school enrollment rates.

Part 3 of the paper documents the increases in rural secondary schools that have occurred in India over the past 40 years as well as the rise in the productivity of high-yielding-variety crops. The new data indicate that there has been considerable progress over this period in the availability of rural secondary schools. In 1960, less than a third of villages were located within 10 kilometers of a secondary school; now almost 90% of the villages have access to at least one secondary school. Rates of secondary school construction have been particularly rapid in the poorer villages, and the distribution in the availability of secondary schools across Indian states is far less unequal in 1999 than 40 years ago, although there are still large disparities. The progress in rural secondary school building has been accompanied over the same period by a rapid increase in crop productivity. The data show, however, that rates of increases in yields have slowed in recent decades, and our analysis of the data suggests that farmers expect that yield growth will slow down further in the future. This, of course, will not necessarily lead to reduced returns to schooling to the extent that there is a growth in opportunities to employ skills in the non-agricultural sector.

In part 4 we show that land prices and current land productivity predict well future growth rates and in part 5 we exploit this to estimate the effects of expected future productivity increases on the building of secondary schools. The estimates suggest that expected growth rates
in productivity have had significant effects, for given wealth levels, both on school construction and on enrollment rates that exceed wealth effects. The results are thus consistent with the hypotheses that the returns to schooling are higher in a dynamic environment and that the Indian population responds to expectations of higher returns to schooling with respect to both school construction and schooling investment. Augmenting and sustaining the rate of economic growth is thus a powerful policy tool for increasing the human capital of the population.

2. Framework

We wish to test the proposition that economic growth is an important determinant of the demand for schools because it raises the returns to schooling. Any analysis of investment in schooling, however, must take into account that plans for rural investments in schools in any period are driven not by current returns but by the expected returns to schooling in that period. In an agricultural context, based on the idea that schooling has higher payoffs in a dynamic environment, expected schooling returns will in turn depend positively on the expected rate of agricultural technical change. This variable thus should thus play a role in influencing school building, along with current wealth, preferences for schooling unrelated to schooling returns, population size and the existing stock of schools.

Of course, at any time t the future rate of productivity growth is unknown. The challenge in identifying empirically whether schooling decisions are influenced by expected growth and thus by the prospects of returns to schooling arises from the fact that, unlike actual income or yield growth, expected productivity cannot be readily measured using household survey data. Nor is having information on actual future productivity growth sufficient. This is because actual productivity growth is a noisy estimate of expected productivity growth. Estimates of the effect of expected growth on school investment based on actual future productivity growth would be biased due to this measurement or forecast error.

A standard treatment for measurement error is instrumental variables. What is needed is a variable observed at time t that predicts expected productivity growth but does not otherwise affect current investment plans. We make use in our empirical analysis of the fact that the price of any plot of land, given an efficient market for land, reflects expectations about the stream of future revenue on that land, appropriately discounted. The price of agricultural land, however,
for given wealth, should have no direct effect on school building.\textsuperscript{4}

A second problem in identifying empirically whether schooling responds to changes in expectations of future growth is the presence of persistent, culturally-determined factors that influence preferences for schooling. For example, as shown below, the Indian state of Kerala has for many decades been marked by higher school investments than other states, although there is no evidence that rates of returns to schooling were ever higher there. Persistent preferences for schooling will in general be correlated with the existing stock of schools. Moreover, land prices will be higher in areas with higher tastes for schooling as long as more schooling results in greater returns to technical change. Thus land prices could not be used as an instrument for identifying the effects of expectations about future growth using cross-sectional data.

In the Appendix we show that the standard remedy for controlling for time invariant unobservables by differencing and applying instruments is, conversely, complicated by the non-observability of expected productivity and we indicate a method for dealing with this problem that relies on using the economics of land price determination. A key assumption is that we have the correct equation describing expectations. While this assumption is not directly testable due to the non-observability of expected incomes, we establish an indirect specification test in which one regresses future output growth on current income, wealth, the land price, and a measure of lagged yields. A significant coefficient on lagged yields would suggest that measurement error is present and thus would invalidate the identification strategy suggested above.

3. Data

To carry out our analysis of the effects of expectations of growth on school building, we need data for multiple time periods that provide information not only on schools, but also on land prices, wealth, population size, and yields. The data used in this study are constructed from data files produced by the National Council of Applied Economic Research (NCAER) from six rural surveys carried out in the crop years 1968-69, 1969-70, 1970-71, 1981-82, and 1999-2000. The first set of three survey rounds from the Additional Rural Incomes Survey (ARIS) provides information on over 4500 households located in 261 villages in 100 districts. These sample households are meant to be representative of all households residing in rural areas of India in the

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\textsuperscript{4} We assume that in an agricultural context, the price of land is a negligible direct cost component in the building of a school.
initial year of the survey excluding households residing in Andaman and Nicobar and Lakshadwip Islands. The most detailed information from the initial set of three surveys is available for the 1970-71 crop year and covers 4,277 households in 259 villages. The 1981-82 survey, the Rural Economic and Demographic Survey (REDS), was of a subset of the households in the 1970-71 ARIS survey plus a randomly-chosen set of households in the same set of villages, excluding the state of Assam, providing information on 4,596 households in 250 villages. 248 of these are the same villages as in the ARIS. Finally, in 1999 households in the same set of original ARIS villages, this time excluding villages in the states of Jammu and Kashmir, were included in a new survey, the 1999 REDS. This survey is in the field at the time the research for this paper was carried out. However, information on the characteristics of the sample villages was complete.

The combined data sets provide information over a period exceeding thirty years for 240 villages spread throughout India on village infrastructure, household assets, demography, schooling investment and attainment, wealth, asset prices, and crop productivity. The timing of the surveys is particularly fortunate for the study of the consequences of economic growth. The initial survey occurred at the onset of the “green” revolution in India, which began in the late 1960's with the importation of new, high-yielding seeds for, principally, wheat, corn and rice. Since that time Indian agriculture has experienced continuous improvements in crop productivity, including as well improvements in such crops as sorghum and cotton. Productivity in agriculture since the late 1960's, however, also grew very unevenly across areas of India, in large part due to persistent differences in agroclimate suitability for the new seeds.5

The 1999 REDS provides information on the history of school building in all of the surveyed villages, providing the dates of establishment for schools located within 10 kilometers of the villages classified by whether they were public, private, aided, or parochial and by schooling level - primary, middle, secondary, and upper secondary. It is thus possible to examine the determinants of school building over the entire span of the sample periods, relating intervals of school investment to initial village conditions.

Before looking at this time-series of schooling investments, however, it is useful to assess

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5 Foster and Rosenzweig (1996) show that net of differential investments in schooling and irrigation, among other endogenous changes, rates of increase in profitability over the period 1971-82 varied substantially across Indian states, districts and villages.
the accuracy of the data that is based on recollection. We can do this only indirectly - neither the
1971 ARIS nor the 1982 REDS provides a history of school building with which to compare that
obtained in 1999 for overlapping years. However, both the 1982 and 1999 REDS provide a
retrospectively-ascertained history of village electrification. We compared the overlapping years
of these two histories, from 1925 through 1982, and found them to be quite close. Regressing the
dates of electrification obtained in 1999 on those obtained in 1982 for the overlapping 1925
through 1982 interval resulted in a coefficient of 1.02 (t=87.6), indicating a very small degree of
“telescoping”. And the correlation between the two series of dates is .989. Thus we believe the
school building histories accurately reflect the true changes in school availability over the last
forty years in the 240 villages, with one caveat - that there are few schools that have been
destroyed over the period, which would not be reflected in a school-building history based on
schools in existence in the villages in 1999.

For the analyses here, we will look at secondary, inclusive of upper secondary, schools. We do this because even in the 1960's primary schools were nearly universal - by 1971 primary
schools were located within 90% of the sample villages. The relevant margin is at the secondary
school level. Figure 1 displays the growth in the average number of secondary schools located
within 10 kilometers of the 240 villages at ten-year intervals from 1960 through 1999. As can be
seen, there has been remarkable growth - from an average of .31 schools per village in 1960 to
almost .9 in 1999. Figure 2 shows, moreover, that the decadal rate of building secondary schools
increased over the 1960-89 period, but has slowed in the last decade.

The school establishment histories also indicate that there were large inter-state
disparities in the presence of rural secondary schools 1960, but show as well that there have been
substantial variations in state-wide school investments since then. Figure 3 provides the average
number of proximate secondary schools per village by state in 1960 and 1999. The 1960 figures
indicate the well-known and commented-upon fact that the state of Kerala was the most
advanced state in terms of educational attainment. Indeed, the graph shows that Kerala had the
largest number of secondary schools per village by a large amount - almost 40% more secondary
schools per village than the next highest state (West Bengal) - a lead that is still in evidence now.
However, rural rates of secondary school building have been substantially higher in many of the
other states since 1960, and the distribution of secondary schools across states is far less unequal
than it was in 1960, although there are still substantial disparities in secondary school
Another way of looking at the change in the distribution of secondary school availability over time is to divide up the villages by average per-household wealth levels. Figure 4 depicts the change in the stock of secondary schools proximate to households for four classes of villages based on average per household wealth in 1971. The figures show that in 1960 the wealthiest quartile of villages had the fewest number of nearby secondary schools, the upper middle quartile villages had the most secondary schools on average, while the lowest-quartile villages had the second highest number of proximate schools. By 1999, however, there is a perfect inverse correlation between the ranks of villages in the 1971 wealth distribution and their rank in terms of secondary school proximity. This is evidently because the lowest two quartile groups of villages based on wealth levels in 1971 experienced the highest rates of increase in secondary school building over the last 40 years.

The combined 1970-71, 1981-82 and 1999 surveys also enable the construction of measures of crop productivity and thus productivity changes by village over the past 40 years. For the first two of these surveys, we obtained for each village median crop productivity for each of five crops - wheat, rice, corn, sorghum and cotton - for both high-yielding (HYV) and traditional seed varieties based on individual farm household information on crop- and variety-specific acres planted and output. For each of these two survey years and each village we then weighted these crop- and variety-specific yields by the proportions of area planted that year in the village and by national 1971 crop-specific prices.⁶ We carried out a slightly different procedure with the 1999 data because the yields by crop and variety were only available at the village level. We constructed a comparable yield measure for that year weighting the crop- and variety-specific yields in 1999 by their respective planted areas and again using 1971 crop prices. To construct a time-series of yields for the villages, we used the resulting Laspeyres-weighted yields for HYV crops, substituting traditional-variety yields only for those villages not growing any HYV crops. The time-series of yields is thus the “max-median” of yields for the villages. The yield index increases over time as (i) HYV seed productivity increases due to improvements in seed technology and to increases in irrigation and (ii) as any farmers in a village are able to

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⁶ The prices are: 75 rupees per quintal for wheat, 60 rupees per quintal for rice, 53 rupees per quintal for corn, 75 rupees per quintal for sorghum, and 225 rupees per quintal for cotton.
adopt HYV crops.\(^7\)

Figure 5 displays the Laspeyres-weighted average per-acre yield indices based on the survey data for the years 1971, 1982 and 1999, and an estimate of yields for 1961, based on the assumption that no farmers could have been using HYV seeds in that year and on the proportion of farm land in 1971 devoted to HYV (5\%). As can be seen, there has been remarkable growth in yields over the last 40 years, with yields rising from 230 rupees per acre in 1961 to over a thousand rupees per acre in 1999. The annual per-acre increase in yields over the three periods 1961-70, 1971-81, 1982-99, shown in Figure 6, exhibits an inverted-u shape - yield increases have slowed since 1982. Interestingly, the annual rates of increase in secondary school building exhibit the same inverted-u pattern. Figure 7 also indicates that rates of increase in yields over the period 1971 through 1999 were inversely related to the villages’ location in the 1971 (average per-household) wealth distribution, with the lowest-wealth villages experiencing the highest rates of increase in yields. The green revolution evidently did not favor most the wealthiest areas.\(^8\)

It is tempting to conclude from the figures tracking aggregate yield growth and school building and the experiences of the different wealth-classes of villages that school building and growth are importantly related. However, the decline in rates of increase in crop yields may be due to a slowdown in the spread of irrigation between the decades of the 1970's, the 1980's and 1990's, and may also be influenced by differences in weather across the survey periods. And the overall decline in rates of school building may be due to the increased stock of schools that had accumulated by the early 1990's. School building may also have contributed to growth rates in yields. Comparisons of these rates are thus not necessarily informative about the influence of yield increases and thus the returns to schooling on the demand for schooling.

To ascertain whether school building is responsive to expectations about returns and thus expected growth in productivity, we implement the procedure outlined in the previous section, using data on yields from the 1970-71, 1981-82 and 1999 surveys, variables indicating whether yields in those years were adversely affected by weather, land prices, village population size, variables.

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\(^7\) If more farmers adopt HYV crops within a village, and crop-specific shares remain constant, there is no measured increase in crop productivity - the potential for productivity growth for any farmer is not affected.

\(^8\) Within a geographic area, larger landowners benefited more than small landowners and the landless from crop productivity augmentation (Foster and Rosenzweig, 1999).
shares of cultivated land irrigated in 1971 and 1982, and the histories of school building. We also constructed mean household wealth in 1971 and 1982 based on the information provided in the household surveys on the value of landholdings, farm equipment, animals and irrigation assets. Distinguishing between wealth effects and expected return effects is critical to the analysis, and the detail on asset holding in the surveys is an important feature of the data. Finally, we constructed school enrollment rates for children aged 10-14, by gender, for the 1970-71 and 1981-82 years to see whether wealth and expected returns influenced not only investments in school buildings but also the actual schooling of the village residents.

Table 1 reports the means and standard deviations of the variables used in the analysis for the three survey years, where available. The figures indicate that most of the elevated rate of secondary school building in the 1980's was due to the addition of public schools, and that while the overall rate of secondary school building dropped in the 1990's, the building of private schools increased in that decade compared to the previous one. The data also indicate that not only did the number of schools increase between 1971 and 1982, but so also did the school enrollment rates of children, particularly for girls. Enrollments rates for boys increased by 8% over the eleven-year period, but that for girls increased by over 64%. The relative gains for girls reduced but did not erase the disparities in sex-specific enrollment rates that existed in the prior period - the enrollment rate for girls is still 71% that of boys in 1982; this figure was, however, 47% in 1971.

The data also indicate that some of the slowdown in the gains in yields between the 1970's and the 1982-99 period was due to both a slightly higher incidence of adverse weather in 1999 compared to earlier years and a slower pace in the rise in the share of irrigated land. The share of cultivated land that was irrigated rose from 42% in 1971 to over 60% in 1982. Between 1982 and 1999, however, irrigation coverage only increased from 60% to 63%. The prices of irrigated land, in 1971 rupees, rose by only a small amount between 1971 and 1982, but almost tripled in real terms between 1982 and 1999. Average wealth per household also increased in real terms between 1971 and 1982 by 8%, reflecting in large part the modest rise in land prices.

4. Land Prices and Expected Yield Growth

We first assess whether current land prices reflect expectations of future productivity
growth by estimating an equation in which the actual future rate of growth in yields in a village is a function of the current land price, current yields corrected for weather shocks and forecast error. In addition, we include in the equation village population growth and the share of land that is irrigated. Population growth, for example, would increase the price of land without any change in yield expectations. Similarly, to the extent that current yields reflect improvements in land through investment, they will overpredict future yield growth.

The dependent variable is the village-specific annual rate of growth in yields. Because we have three observations on yields, for 1971, 1982 and 1999, we have two sets of growth rates for each village and we can stack the two earliest sets of village-level observations. Theory does not provide guidance on the functional form for the forecast equation. Because we are interested in obtaining the best prediction for future productivity, we the growth equation using two functional forms, employing alternatively as right-hand-side variables either the linear form or the log of land prices, yields, and village population size. We also include in both specifications the changes in the share of land that is irrigated between the period 1971-82 and 1982-99 to take out from future yield growth that part due to investments.

Columns 1 and 2 of Table 2 report the estimates of the future yield growth equation for the two functional forms. All t-statistics are corrected for the fact that we have non-independent observations within villages. The signs of all of the parameters are as expected - in particular, net of current yields and the effects of population pressure on land prices, land prices have a positive and statistically significant relationship with future yield growth. And, net of land prices, the higher are current yields and population size, the lower is future productivity growth, reflecting the fact that both are factors that push up the current price of land independent of expectations. In terms of explanatory power, the equation employing logs of the price, yield and population variables performs substantially better, explaining more than half of the variation in future yield growth, compared with 34% for the linear specification. The log-form also more easily passes the test that the residuals from the forecast equation, which are supposed to reflect only forecast error, are uncorrelated with lagged yields. Regressing the residuals from the 1982 prediction on, respectively, the log and level of the yields in 1971 from the log and linear equations resulted in

9 This is equation (12) in the Appendix.

10 Only a small part of this of this is due to the inclusion of future irrigation changes. Exclusion of this variable reduces the R² to .498.
coefficients with t-values of, respectively, 0.65 and 1.34.

The point estimate of the log of the land price suggests that, for given current yields and population size, an expected one percentage point increase in sustained annual yield growth rates would be associated with a 50% increase in current land prices. Land prices thus appear to be a moderately sensitive and statistically significant predictor of yield growth. We can thus use the estimates from Table 2, along with the actual 1999 values of land prices and yields, to infer what Indian farmers currently expect the future rate of growth in yields to be. Based on the 1999 values, the estimates suggest that farmers expect to experience a yield growth rate of 3.5% per year, in the absence of increased irrigation coverage. It is notable that this figure is lower than the average annual increase in yields experienced in the 1982-99 period, even corrected for the moderate increase in irrigation coverage over that period. Farmers appear to believe that the benefits of the green revolution are diminishing.

5. Expected Growth, Wealth and School Investment

Table 3 reports separate estimates of the effects of expected growth rates, wealth levels and the existing stocks of secondary schools on new secondary school building for all secondary schools, for public schools and for non-public schools. The estimates are obtained using fixed-effects with instrumental variables to eliminate the influences of both fixed areal preferences for schooling and errors in forecasts that will bias the estimates. The variables included in addition to wealth, weather, land price, and school stocks, as noted, serve to minimize bias in the key variable coefficients in the presence of forecast errors. The estimates are consistent with the hypothesis that the building of new secondary schools responds positively to expectations of future yield growth, for given levels of wealth and given the existing stock of schools. And, increases in wealth, net of changes in expectations of future growth, also appear to have a positive effect on subsequent school construction. The point estimates for total secondary schools suggest that a rise in the annual rate of growth in yields from, say, the expected 3.5% to 4.5% would increase by 24% the number of secondary schools built over a ten-year period for the average village. Given expectations about future yield growth, this effects is equivalent to an increase in average wealth of 30%, which the point estimates suggest would increase the number of secondary schools in a decade by 21% on average. Wealth increases thus appear to have a significant but less powerful effect on rural secondary school construction compared with raising
the expected growth rate and thus the returns to schooling.

The sets of non-public and public school estimates indicate non-rejection of the hypothesis that each type of school responds equally to changes in expectations and wealth. The estimates of the determinants of decisions about new school building thus suggest that public and private secondary schools are viewed as close substitutes by the villagers.

Do the effects of expected returns and wealth on secondary school accessibility show up as well in schooling investments? The household survey data for 1971 and 1982 provide information, elicited from the households, on the numbers of children enrolled in school. These data thus do not suffer from the problems associated with enrollment information provided by school officials, who have an incentive to inflate enrollment figures.\(^{11}\) Table 4 reports estimates of the determinants of school enrollment rates for all children aged 10-14 and for boys and girls separately in the same age category. These estimates indicate that both school construction and investments in schooling respond positively to expected yield growth. The point estimates suggest that a 10% rise in the expected annual growth rate in yields, for given initial wealth levels, would raise overall rural school enrollment rates by 5%, that for boys by almost 7% and that for girls by 3.3%. However, wealth appears to have an insignificant but negative effect on overall enrollment rates.

Does the lack of a positive wealth effect on schooling call into question the results for school building? The facts that enrollment rates reflect the allocation of time, while school construction does not, plus the separate sets of estimates for boys and girls provide an answer. The enrollment rate estimates indicate that enrollment rates for boys respond strongly and positively to changes in expected future increases in yields, but boys’ enrollment in school declines with increases in household wealth, for given growth expectations. In contrast, the wealth effect on enrollment for girls is positive, and the enrollment response of girls to expected future yield growth is substantially smaller than that for boys. These results together are consistent with the division of labor between boys and girls - boys are much more likely than girls to engage in activities that contribute to the household’s farm income than are girls. Wealth in the rural villages is dominated by land wealth, and greater land wealth reflects the higher

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\(^{11}\) However, the data on enrollment, even if accurate, may overstate the amount of investment in schooling to the extent that there is variation in school attendance. Only the 1982 survey provides information on children’s time devoted to “study.”
productivity of inputs, including labor inputs, on the land. The negative wealth effect for boys thus reflects the opportunity cost of the time of boys who attend school.

The contrast between the enrollment rate equations for boys and girls thus makes visible the roles of the two components of the returns to schooling - opportunity costs and profitability. Increases in the productivity of land increase the opportunity cost of attending school for those children used in farm production, but expected increases in yield rates, expected growth, raise the gross returns to investments in skills, skills that have enhanced payoffs in a dynamic environment. A one-shot increase in productivity thus may reduce schooling investment, while the change to a regime of sustained, rapid growth in productivity will raise investments in schooling.

6. Conclusion

The newly-constructed times series data on 240 villages across most of rural India suggest that there has been considerable progress in the last 40 years in the availability of rural secondary schools. In 1960, less than a third of villages were located within 10 kilometers of a secondary school; now almost 90% of the villages have access to at least one secondary school. Rates of secondary school construction have been particularly rapid in the poorer villages, and the distribution in the availability of secondary schools across Indian states is far less unequal now than 40 years ago, although there are still large disparities.

The progress in rural secondary school building has been accompanied over the same period by a rapid increase in crop productivity. The data show, however, that rates of increases in yields have slowed in recent decades, and our analysis of the data suggests that farmers expect that yield growth will slow down further in the future. Our analysis also suggests that expected growth rates in agricultural productivity have had significant effects, for given wealth levels, on school construction and on enrollment rates, while wealth effects, for given productivity increases, have on average had negligible effects on enrollment. These results are consistent with the hypothesis, advanced by many economists, that returns to schooling are higher in a dynamic environment and suggest that the Indian population responds to expectations of higher returns to schooling with respect to both school construction and schooling investment.

Our findings, based on the large spatial variation in productivity growth that has been experienced in India over the last 40 years, suggest that augmenting and sustaining the rate of
economic growth is a powerful policy tool for increasing the human capital of the population. The results should not be interpreted, however, as implying that augmenting agricultural growth rates leads to increased employment in agriculture. As farmers’ wealth levels increase, so does the demand for non-agricultural products, creating new opportunities for the use of skills outside of agriculture. When the new 1999-2000 household survey data are completed it will be possible to assess to what extent agricultural productivity growth was associated with rural, non-agricultural employment, by schooling level. Nor should these findings be interpreted as suggesting that the only route to raising human capital levels is via investments in agricultural productivity. There are clearly areas of India in which the potential for raising crop productivity is low. To the extent that opportunities are expanded for the exploitation of skills outside of agriculture that arise, say, from the freeing up of market restrictions, we would expect similar responses with respect to schooling investment. The results are also consistent with the idea that increased schooling, just as it facilitates the exploitation of new agricultural technologies by farmers, enhances abilities to exploit opportunities outside of agriculture and even outside the rural sector.

Appendix: Using the Land Price to Identify the Effects of Expected Growth on School Building

We posit a model in which plans for rural investments in schools in any period $t$ over the subsequent interval $t$ to $t+1$ is driven by the expected returns to schooling at time $t$, which we assume to be positively related to the expected rate of agricultural technical change. Investment plans are also influenced by current wealth, $A_t$, population size, $N_t$, and the existing stock of schools, $S_t$, at time $t$. At time $t$ the rate of productivity growth between periods $t$ and $t+1$, $r_t$, is unknown, so that schooling decisions must be made based on expectations as of time $t$. Let $s_t$ denote new school investment and $E_{r_t}$ denote the time-$t$ expected rate of growth in agricultural productivity between periods $t$ and $t+1$. If $e_t$ is the deviation of actual from expected growth, then the true rate of increase in productivity is

\[ r_t = E_t r_t + e_t, \]

with $e_t$ uncorrelated with anything known by the school investors at time $t$. The schooling decision rule may thus be written as

\[ s_t = \beta_r E_{r_t} + \beta_A A_t + \beta_N N_t + \beta_S S_t + \phi + u_t, \]

where $\phi$ captures time-invariant determinants of schooling decisions that are unmeasured and may vary across decision-making units.
The parameter $\beta_t$ reflects the influence of expected productivity growth on current schooling decisions. Identifying $\beta_t$ is thus the key to assessing whether schools are built in response to growth prospects, which raise the returns to schooling. Using actual future productivity growth to substitute for expected growth in (2) results, however, in inconsistent estimates of $\beta_t$. To see this, substitute equation (1) into (2) to get
\begin{equation}
(3) \quad s_t = \beta_r r_t + \beta_A A_t + \beta_N N_t + \beta_S S_t - \beta_t e_t + u_t.
\end{equation}
Inconsistent parameter estimates arise due to the correlation of $r_t$ with $e_t$, the forecast error. The problem is essentially one of measurement error in that actual productivity growth is a noisy estimate of expected productivity growth. The estimate of $\beta_t$ is biased along with the other parameters in (3) due to this measurement or forecast error.

A standard treatment for measurement error is instrumental variables. What is needed is a variable observed at time $t$ that predicts expected productivity growth but does not otherwise appear in (3). We make use of the fact that the price of any plot of land, $p_t$, given an efficient market for land, reflects expectations about the stream of future revenue on that land, appropriately discounted. Thus
\begin{equation}
(4) \quad p_t = E_t \sum_{s=0}^{\infty} \delta^s y_{t+s},
\end{equation}
where $\delta$ is the discount factor and $y_t$ is revenue from the land in period $t$. Assuming for notational simplicity a constant rate of growth $r_t$ from period $t$ onward, (4) can be rewritten as
\begin{equation}
(5) \quad p_t = E_t y_t \sum_{s=0}^{\infty} \delta^s (1+r)^s = E_t y_t / (1 - \delta (1+r))
\end{equation}
where income in period $t$, given by
\begin{equation}
(6) \quad y_t = E_t y_t + w_t,
\end{equation}
is stochastic due to weather shocks $w_t$. Thus, given (3), the price of land at time $t$ can serve as an instrument for expected future productivity because the land price, conditional on actual land income at time $t$, given by (6), reflects expectations about the future productivity increase $r_t$ but has no direct effect on investment plans, given current wealth.

A second problem, however, is the presence of persistent, culturally-determined factors, impounded in $\varphi$ in (3) that influence preferences for schooling. Such factors will in general be correlated with the existing stock of schools, thus inducing a correlation between the stock variables, $S_t$, and the residual. In the presence of the fixed effect, the instrumental-variables
approach would not work, because, for example, prices will be higher in areas with higher tastes for schooling as long as more schooling results in greater returns to technical change, resulting in a correlation between the instrument and the residuals in (3) which contain preferences $\phi$.

The standard remedy for controlling for time invariant unobservables by differencing and applying instruments is, conversely, complicated by the non-observability of expected productivity. Substituting (2) and differencing across time yields

\[ \Delta s_t = \beta_r \Delta r_t + \beta_A \Delta A_t + \beta_N \Delta N_t + \beta_S \Delta S_t - \beta_r \Delta e_t + \Delta u_t \]

where $\Delta s_t = s_{t+1} - s_t$ and so forth. The standard problem that differenced state variables such as, in this case, $S_t$, are directly influenced by first period shocks $u_t$ can be addressed by instrumenting with initial period stock levels. However, the approach suggested above of using land prices as instruments to remove the measurement error arising from the non-observability of expected productivity must also be modified. In particular, differenced prices are not appropriate instruments because forecast errors in period $t$ to $t+1$, $e_t$, will, definitionally, be correlated with actual incomes in period $t+1$ and will also likely influence the forecast of growth at $t+1$ and thus will be correlated with price in period $t+1$. While, in principle, it is possible to use initial prices $p_t$ to instrument the change in expected productivity growth, there is reason to expect that this instrument would be too weak to be of value in practice.

In order to address this problem we therefore make use of a linear approximation to the price equation (4)

\[ p_t = \gamma_s E_t, \gamma_r E_t r_t \]

Substituting for the expectations variables and solving for $e_t$ yields

\[ e_t = \gamma_s / \gamma_r (y_t - w_t) + r_t - 1 / \gamma_r p_t \]

which may, in turn, be substituted into (7) to obtain

\[ \Delta s_t = \beta_r \Delta r_t + \beta_A \Delta A_t + \beta_N \Delta N_t + \beta_S \Delta S_t + \beta_r (\gamma_s / \gamma_r (y_t - w_t) + r_t - 1 / \gamma_r p_t) - \beta_r e_{t-1} + \Delta u_t \]

which may be simplified to

\[ \Delta s_t = \beta_r r_{t+1} + \beta_A A_{t+1} + \beta_N N_{t+1} + \beta_S S_{t+1} + \beta_r \gamma_s / \gamma_r (y_{t+1} - w_{t+1}) - \beta_r r_{t+1} - \beta_r e_{t-1} + \Delta u_t \]

Note that in (11) growth no longer appears in differenced form and that since $e_t$ no longer appears in the residual, differenced prices may be used to instrument growth in period $t+1$, $r_{t+1}$.

As noted, first period school stocks serve as instruments for the subsequent change in school stocks $\Delta S_t$. 

\[ \text{(11)} \]

\[ \text{(11)} \]

\[ \text{(11)} \]
A key assumption in the above analysis is that equation (9) holds exactly. While this proposition is not directly testable due to the non-observability of expected incomes $E_t y_t$, an indirect specification test may be constructed by solving the price equation (5), given (6), for $r_t$:

$$r_t = -\psi_y/\gamma_y(y_t - w_t) + 1/\gamma_r p_t - e_t$$

If the forecast equation (12) is correctly specified, the residual of this equation contains only the forecast error for the period between $t$ and $t+1$, which must be uncorrelated with any variables known to the village at time $t$. By contrast, if one or more of the observables in (12) are measured with error, a correlation is likely to be observed. A simple specification test is thus to regress $r_t$ on $y_t$, $w_t$, $p_t$, and a measure of lagged yields $y_{t-1}$. A significant coefficient on lagged yields would suggest that measurement error is present and thus would invalidate the identification strategy suggested above.
References


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